

EXPLANATION OF DIAGRAM, PLATE 11.

On the plate are given details of four families of parthenogenetic ♀'s. Fam. 1 contains a few arrenotokous ♀'s, Fam. 2 contains many, whilst Fam. 3 and Fam. 4 show none (*cf.* Types B, A, and C, pp. 226, 227). T denotes a ♀ proved to be thelytokous. A denotes a ♀ proved to be arrenotokous. The small figures in Families 3 and 4 signify the number of the generation from the original parent of the strain. Thus in Family 3, T₉ + 12T means that in the ninth generation 13 ♀'s from the same parent (T₈) were proved to be thelytokous, and that one of these was used as the mother of the tenth generation—the rest being discarded. Where apparent gaps occur, *e.g.*, in Fam. 3, between T₁₇ and T₄₀, it means that a single ♀ was used in each generation to continue the strain, but that the sisters of these individuals were not bred from.

On the Julianiaceæ, a New Natural Order of Plants.

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(Abstract.)

I.—GENERAL DESCRIPTION.

The Julianiaceæ comprise, so far as at present known, two genera and five species. They are resiniferous, tortuously branched, deciduous, diœcious shrubs or small trees, having alternate, exstipulate, imparipinnate leaves, from about one to three decimetres long, clustered at the tips of the flowering branches and scattered along the short barren shoots. The flowers are small, green or yellow-green, quite inconspicuous, and the males are very different from the females. The male inflorescence is a more or less densely branched axillary panicle or compound catkin, from 2½ to 15 cm. long, with weak, thread-like, hairy branches and pedicels. The male flowers are numerous, 3 to 5 mm. in diameter and consist of a simple, very thin perianth, divided nearly to the base into four to nine narrow equal segments, and an equal number of stamens alternating with the segments. In structure and appearance they are almost exactly like those of the common oak. The female inflorescence is similar in structure to that of the sweet chestnut, consisting of an almost closed, usually five-toothed involucre, borne on a flattened pedicel and containing three or four collateral flowers, of which the two outside ones are, perhaps, always abortive.

At the flowering stage, the female inflorescences, including the narrow

flattened pedicel and the exserted styles, are about 2 cm. long, and as they are seated close in the axils of the crowded leaves, and of the same colour, they are easily overlooked. The female flowers are destitute of a perianth, and consist of a flattened, one-celled ovary, terminated by a trifold style and containing a solitary ovule. The ovule in both genera is a very peculiar structure. I will first describe that of *Juliania*. In the flowering stage it is a thin, flat, obliquely horseshoe-shaped or unequally two-lobed body, about 2 mm. in its greatest diameter, attached to the base of the cell. At a little later stage, in consequence of unequal growth, it is horizontally oblong, nearly as large as the mature seed, that is 6 to 8 mm. long, and almost symmetrically two-lobed at the top. A vascular bundle or strand runs from the point of attachment to the placenta upwards near the margin into one of the lobes. In this lobe the embryo is tardily developed, and at this stage it is more or less enclosed in the opposite lobe, the relations of the two being as nozzle and socket to each other. It is assumed that the whole of this body, with the exception of the lobe in which the embryo is formed, is a funicle with a unilaterally developed appendage, which breaks up and is absorbed during the development of the ovule into seed. A similar growth and transformation is unknown to me in any other natural order.

The ovule of *Orthopterygium* is very imperfectly known, but the attachment appears to be lateral and the funicular appendage cup-shaped at the basal end, bilamellate upwards, and more or less enclosing the embryoniferous lobe.

Mr. Boodle, who has fully examined the ovule of *Juliania* from microtome sections, describes it as hemianatropous with a single integument.

The compound fruits of *Juliania* are samaroid in form, the wing being the flattened pedicel, at the base of which it disarticulates from the undifferentiated part of the pedicel. They vary from 4 to 7 cm. in length by $1\frac{1}{2}$ to $2\frac{1}{2}$ cm. in width. Externally they strongly resemble the samaroid pods of certain genera of Leguminosæ, notably those of *Platypodium* and *Myroxyylon*. The involucre itself, of the largest fruits seen, is only about 1 cm. deep by 2 cm. wide. It is composed of very hard tissues and is quite indehiscent. Only quite young fruit of *Orthopterygium* is known. In this the flattened pedicel is narrow, straight and æquilateral, from 6 to 7 cm. long and about 1 cm. wide.

The nuts of *Juliania* are almost orbicular, biconvex, hairy on the outside and have a very hard endocarp. The solitary exalbuminous seed is circular or oblong, 6 to 10 mm. long, compressed, with a smooth, thin testa. The embryo is horizontal, with thin plano-convex, more or less oblique, obscurely lobed cotyledons, which are epigeæous in germination, and a long ascending radicle applied to the edges of the cotyledons.

II.—HISTORY.

It is surprising that a genus of plants so striking in aspect, so distinct in the shape of its fruit, and so widely spread as *Juliania* is in Mexico, should have entirely escaped the observation of all the earlier European travellers in that country.

C. J. W. Schiede, M.D., who accompanied Ferdinand Deppe on a botanical expedition to Mexico in 1828, was apparently the first to send dried specimens to Europe of one of the species of *Juliania*. But it was not until 1843 that his friend, Dr. D. F. L. von Schlechtendal, published an account of the genus of plants in question.

Under the name of *Hypopterygium* (subsequently *Juliania*) *adstringens*, he very fully described the material he had an opportunity of examining, but he had neither female flowers nor mature seeds, and he was doubtful whether the fruit was the result of one or more flowers. His description is very accurate, and he expresses his views of the affinities of the plant, which he regarded as the type of a new Natural Order. Since Schlechtendal's time, until I took up the study of the genus five years ago, nobody seems to have had sufficient material to supplement his description.

In 1854, A. Gray described, also from very incomplete material, what he considered a second species of the same genus, collected in Peru. An examination of fuller, though by no means complete, material has led me to separate it generically under the name of *Orthopterygium*.

In September, 1900, the late Mr. Marc Micheli presented Kew with a small set of E. Langlasse's Mexican plants. Among them was a specimen in fruit, which, after much research, was identified with Schlechtendal's *Juliania adstringens*; but the most careful and tedious examination carried me no further than Schlechtendal had reached 60 years before. Previous to this (in 1899, as I afterwards found out), Kew received a specimen of a male plant collected in the Mexican State of Jalisco by Mr. C. G. Pringle, n. 6871, and doubtfully named *Juliania adstringens*.

The male specimen was published as *Juliania mollis*, Hemsl., and the fruiting as *J. adstringens*, Schl.

This publication had the desired effect, for it brought me a letter at the end of 1901 from Dr. J. N. Rose, Curator in the "Division of Plants" of the United States National Museum at Washington, from which I make the following extracts:—

"You will also be interested in what I have to tell you about *Juliania*. For more than six years I have been at work off and on, at this genus, but for the lack of material I have never published anything upon it, but each

time have brought back specimens, and this year was especially fortunate in collecting near the type-locality both male and female plants. In looking up the subject since my return I find that you have anticipated me and have published two very beautiful plates and some interesting notes. . . . There are, however, more than two species in Mexico. I have certainly four well-marked species and possibly six. . . . With regard to the position of this genus, I think it must be regarded as the type of a new order. I do not think it has any relationship to either Burseraceæ or Anacardiaceæ. My conclusions in the field were that it must be closely related to Juglandaceæ, a relationship which you also suggest."

In this communication Dr. Rose most generously offered to send all his specimens and notes to me, leaving it to my judgment in what form publication should be effected. I gladly accepted, and through the kindness of the Trustees of the Bentham Fund, Miss M. Smith made an elaborate series of drawings under my direction. As there were still some structural points on which we were not quite clear, and Dr. Rose contemplated another visit to Mexico, it was decided to publish at once a description of the genus, as then understood, and brief diagnoses of the species.

III.—GEOGRAPHICAL DISTRIBUTION.

1. *Juliania*.

So far as at present known, *Juliania* is confined to Mexico, and the various species occur in isolated localities between about 17°40' and 23° N. lat., and 97° and 104° W. long., and at altitudes of about 1500 to 5500 feet.

2. *Orthopterygium*.

The habitat of the Peruvian *Orthopterygium Huacui* is 2000 miles distant from the nearest locality of any species of *Juliania*. The exact position of the only place in which it has been found cannot be given, but it is in the Province of Canta, in the Department of Lima, between 11° and 12° S. lat.

IV.—THE AFFINITIES OF THE JULANIACEÆ.

During the six years that I have had this small group under observation I have had opportunities of showing the specimens and drawings to many of the leading botanists of the world, and all agree who have seen them that it deserves to rank as an independent order. That being so, the question of its position arises, but that is a point not so easily settled in a linear arrange-

ment. Taking the morphological characters seriatim, it is evident that the closest relationships are with the Anacardiaceæ and Cupuliferæ. The absolute separation of the sexes and the very great diversity of the floral structure of the sexes, associated with pinnate leaves, offers a combination of characters probably without a parallel.

Beginning with the foliage, the Julianiaceæ have alternate, exstipulate, imparipinnate leaves in common with at least eight different ligneous orders, but here the affinity, or, rather, resemblance ends so far as six of them are concerned, and the comparisons need be carried no further. There remain the Anacardiaceæ and Juglandaceæ, both of which are also resiniferous, both have unisexual flowers with reduced envelopes, at least as to some of their members, and both have solitary, exalbuminous seeds. Other points of resemblance or similarity in the Juglandaceæ are the dissimilar male and female flowers, the broad, stigmatic lobes of the style, and the single-coated ovules. *Juglans* has also a funicle of unusual development. But the combined characters in common of the Julianiaceæ and the Juglandaceæ cannot be regarded as constituting a close affinity. In some respects there is a nearer relationship to the Anacardiaceæ. The anatomical characters of the two orders are very much alike; but as Dr. F. E. Fritsch will describe and discuss the anatomy in a separate paper, it is unnecessary to enter into particulars here.

The nearest approach I have found to the singular funicular development of the ovule is in the Anacardiaceæ, but the resemblance is remote and the ovules of the latter are double coated. Coming to the seed and the embryo, however, the resemblance is complete, and, apart from the slight obliquity of the cotyledons of *Juliania*, the description of the seed and embryo of *Cotinus* or *Rhus* would do for *Juliania*. With this the affinities to the Anacardiaceæ are exhausted, and they are not sufficiently strong to justify the juxtaposition of the two orders. The next comparison is with the Cupuliferæ, taking the order as limited by Bentham and Hooker. There is nothing in the secretions nor in the foliage to warrant an approximation of the two orders, and in habit of growth the Julianiaceæ are very different. But divergences as great, or greater, exist between closely associated orders, and even between genera referred to the same order; and when we come to the inflorescence and flowers, affinities are evident; that is if affinities are deducible from similarities in structure.

The male inflorescence, the male flowers, and the pollen of *Juliania adstringens* are so near in texture, structure, and form to the same parts in certain species of oak that, detached, they might be referred to the genus *Quercus*. In fact, there is much greater dissimilarity in the male inflorescence

and flowers of different species of *Quercus* than there is between those of *Juliania* and those species of *Quercus* which have a flaccid male inflorescence and stamens alternating with the segments of the perianth.

The female inflorescence and the male flowers of *Juliania* are not represented by exact counterparts in the Cupuliferæ, but the analogies are perhaps greater than with any other order. Several female flowers in a closed involucre is a characteristic of *Juliania*, of *Fagus*, *Castanea*, and *Castanopsis*. In all three of the genera of the Cupuliferæ named, the involucre dehisces regularly or irregularly, and the nuts fall out. In *Juliania* the involucre is indehiscent, and the flattened nuts are adnate by their edges to the inner wall of the involucre, and they have a very hard, relatively thick, sclerenchymatous pericarp.

Going back to the flowers, the male of *Juliania* has a perianth; the female none. In *Corylus* the conditions are reversed; in *Betula*, neither sex has an obvious perianth; in *Quercus*, the flowers of both sexes are furnished with a perianth.

All of the Cupuliferæ have an ovary which is more than one-celled, and usually there are three cells, and mostly more than one ovule in each cell, though each nut is usually only one-seeded. The ovary of *Juliania* and of *Orthopterygium* invariably contains only one ovule. The flowers and nuts of *Castanea* are collateral, as in *Juliania*. The seeds of both orders are exalbuminous, and the cotyledons are epigæous in germination.

Weighing the characters in which there is agreement or similarity between the Julianiaceæ and the Anacardiaceæ, and those in which there is agreement or similarity between the Julianiaceæ and the Cupuliferæ, the latter in my estimation preponderate; and I cannot suggest a more natural position for the Julianiaceæ, in a linear arrangement, than between the Juglandaceæ and the Cupuliferæ.
